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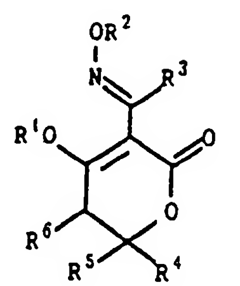
(54) Title: SELECTIVE PYRONE HERBICIDES



(II)

(57) Abstract

Compounds of general formula (II), wherein R^1, R^2, R^3, R^5 and R^6 are various substituents and including the spiro compounds in which R^4 and R^5 together with the carbon to which they are attached form a substituted or unsubstituted, saturated or partially saturated heterocyclic or carbocyclic ring; and herbicidal compositions or methods which involve such compounds.

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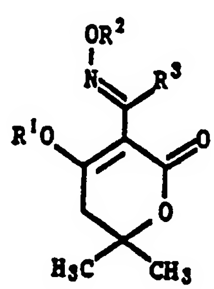
SELECTIVE PYRONE HERBICIDES

This invention relates to organic compounds having herbicidal properties and plant growth regulating properties, to processes for the preparation of such compounds; to intermediates useful in the preparation of such compounds; to herbicidal compositions and processes utilizing such compounds and to plant growth regulating compositions and processes utilizing such compounds.

The use of certain cyclohexane-1,3-dione derivatives as grass herbicides is known in the art. Thus, for example, the compendium "Agricultural Chemicals - Book II Herbicides 1986-87 Revision" (W.T. Thomson Editor, Thomson Publications, California U.S.A.) describes the cyclohexane-1,3-dione derivatives known commercially as Alloxydim Sodium (methyl-3-[1-(allyloxyimino)butyl]-4-hydroxy-6,6-dimethyl-2-oxocyclohex-3-ene carboxylate), Cloproxydim ((E,E)-2[1-[1-[(3-chloro-2-propenyl)oxy]imino]butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cylohexen-1-one) and Sethoxydim (2-[1-(ethoxyimino)butyl]-5-[2-ethylthio]propyl-3-hydroxy-2-cyclohexen-1-one) as selective post-emergent herbicides. Alloxydim and Sethoxydim have been disclosed in Australian Patent No. 464 655 and Australian Patent Application No. 35,314/78 respectively.

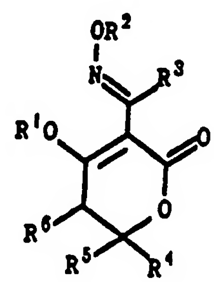
Pyrones of the general formula (1) have been claimed to show herbicidal activity (Japan Kokai 76 63175 (Chemical Abstracts, 86:72439y)).



(1)

We have discovered that compounds similar to the general formula 1 but which bear substituents at the 5-position other than hydrogen and substituents at the 6-position other than hydrogen or geminal dimethyl exhibit particularly useful herbicidal activity and plant growth regulating activity. In either pre-emergent (soil treatment) or post-emergent (foliar) application the compounds of the invention are superior to the prior art compound in their selectivity for weed grasses in graminaceous crops.

Accordingly, the invention provides a compound of the general formula (2)



(2)

wherein

R^1 is selected from the group consisting of: hydrogen; alkyl; alkenyl; alkynyl; substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio, optionally substituted phenyl, optionally substituted heterocycle; optionally substituted phenyl; optionally substitued heterocycle; alkyl sulfonyl; optionally substituted benzene sulfonyl; an acyl group; and an inorganic or organic cation;

R^2 is selected from the group consisting of: alkyl; alkenyl; haloalkenyl; alkynyl; haloalkynyl; substituted alkyl wherein the alkyl

group is substituted with a substituent selected from the group consisting of halogen, alkoxy, alkylthio, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; and optionally substituted heterocycle;

R^3 is selected from the group consisting of: alkyl; fluoroalkyl; alkenyl; alkynyl; and optionally substituted phenyl;

R^4 is selected from the group consisting of: alkyl other than methyl; alkenyl; alkynyl; haloalkyl; cycloalkyl: cycloalkenyl; substituted alkyl or substituted cycloalkyl wherein the alkyl or cycloalkyl group is substituted heterocyclo; oxo; acyl; alkoxy; alkylthio; alkoxycarbonyl; (alkoxyimino)alkyl; ketal; and carboxylic acid.

R^5 is selected from the group consisting of: alkyl; alkenyl; alkynyl; haloalkyl; haloalkenyl; cycloalkyl; cycloalkenyl; substituted alkyl or substituted cycloalkyl wherein the alkyl or cycloalkyl group is substituted with a substitutent selected from the group consisting of alkoxy, alkylthio, oxo, acyl, alkoxycarbonyl, (alkoxyimino)alkyl, ketal, carboxylic acid, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; and optionally substituted hererocycle;

OR

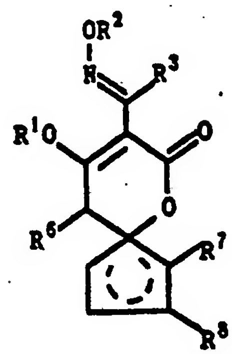
R^4 and R^5 together with the carbon to which they are attached form a substituted or unsubstituted saturated or partially saturated heterocyclic or carbocyclic ring containing 3 or more ring atoms. The

ring may be bridged or fused and the ring substituents are selected from the group consisting of hydrogen; alkyl; alkenyl; alkynyl; substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; and optionally substituted heterocycle; oxo; acyl; alkoxy; alkylthio; alkoxycarbonyl; (alkoxyimino)alkyl; ketal; and carboxylic acid.

R^6 is selected from the group consisting of : alkyl, alkoxy, alkylthio, halogen or substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio or halogen.

A preferred group of compounds of general formula (2) consists of spirocyclic derivatives of the general formula (3), (4) and (5). For these novel derivatives, R^1, R^2 and R^3 are as specified above. For the spirocyclic derivatives (3) and (4) the non-lactone ring may be saturated or partially unsaturated and R^7 R^8 and R^9 are selected from the group consisting of: hydrogen; halo; alkyl; alkenyl; alkynyl; substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of halo, alkoxy, alkylthio, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; and optionally substituted heterocycle; oxo; acyl; alkoxy; alkylthio; alkoxycarbonyl; alkoxyimino) alkyl; ketal; and carboxylic acid. R^6 is selected from the group consisting of: alkyl, alkoxy, alkylthio, halogen or substituted alkyl wherein the alkyl group is substituted with a substituent selected from

the group consisting of alkoxy, alkylthio or halogen.



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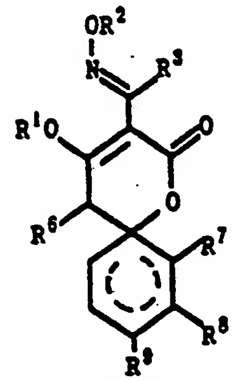

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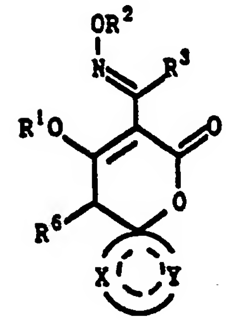


(5)

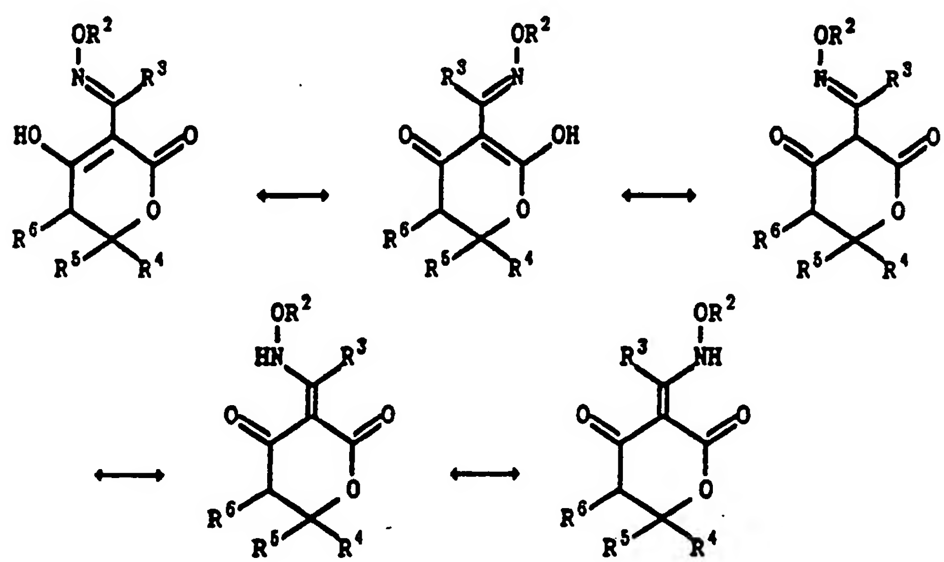
For the novel derivatives (5), the polyatomic ring containing X and Y is a substituted saturated or partially saturated heterocyclic ring containing 5,6 or 7 ring atoms. The heterocyclic ring may contain one or more heteroatoms selected from the group consisting of oxygen, nitrogen and sulfur, and the ring substituents are selected from the group consisting of: hydrogen; alkyl; alkenyl; oxo; acyl; alkoxy; alkylthio; ketal; alkoxycarbonyl; (alkoxyimino)alkyl; substituted alkyl wherein the alkyl group consisting of alkoxy, alkythio, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; and optionally substituted heterocycle. R^6 is selected from the group consisting of alkyl, alkoxy, alkylthio, halogen or substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio or halogen

In all of the above alkyl, alkenyl and alkynyl include straight-chain and branched-chain structures.

In all of the above heterocycle means a mono- or poly-cyclic heterocyclic ring structure that contains one or more heteroatoms and may or may not be aromatic. Suitable heteroatoms are nitrogen, oxygen, sulphur. The heterocyclic ring preferably has more than three atoms in the ring. Some examples of suitable heterocycle groups are thiophenyl, benzofuranyl, furanyl, morpholino, and pyridyl.

Preferably in all of the above alkyl, alkenyl, alkynyl means lower alkyl, alkenyl or alkynyl. More preferably alkyl, alkoxy, alkylthio, haloalkyl, alkyl sulphonyl or substituted alkyl groups contain 1 to 6 carbon atoms and alkenyl, alkynyl, haloalkenyl, or haloalkynyl groups contain 2 to 6 carbon atoms.

It should be recognized that when R^1 is hydrogen the compounds (2) of the invention may undergo tautomerism and exist in any one of five forms as shown below.



All tautomeric forms are included in the scope of this invention. Particularly preferred choices for R^1 include hydrogen and the

alkali metal cations.

Preferred choices for R^2 include alkyl, alkynyl, alkenyl and haloalkenyl.

Particularly preferred choices for R^2 include ethyl, propargyl, allyl and 2- and 3-chloroallyl.

Particularly preferred choices for R^3 include ethyl and n-propyl.

Particularly preferred choices for R^6, R^7, R^8, R^9 and substitutents of the polyatomic chain XY include H and methyl. Particularly preferred choices for R^6 include methyl and ethyl.

Where isomers may exist useful compositions may consist of the isomers separately or in mixtures in any possible ratio.

Certain of the compounds of formula (2) exhibit useful plant growth regulating activity. For example, while certain compounds of formula (2) show selective herbicidal activity against wild grasses in crops of cultivated plants, at some rates of application they exhibit plant growth regulating effects in said crops. Certain of the compounds of Formula (2) may be used for selective control of wild grass in graminaceous crops.

Plant growth regulating effects may be manifested in a number of ways. For example, suppression of apical dominance, stimulation of auxiliary bud growth, stimulation of early flowering and seed formation, enhancement of flowering and increase in seed yield, stem thickening, stem shortening and tillering. Plant growth regulating effects shown by compounds of the invention include, for example, tillering and stem shortening in crops such as wheat and barley.

Accordingly in yet a still further aspect the invention provides a

process for regulating the growth of a plant which process comprises applying to the plant, to the seed of the plant, or to the growth medium of the plant, an effective amount of a compound of formula (2), as hereinbefore defined.

To effect the plant growth regulating process of the present invention the compounds of formula (2) may be applied directly to the plant (post-emergence application) or to the seed or soil before the emergence of the plant (pre-emergence) application.

The compounds of the invention are substantially more effective against monocotyledenous plants or grass species than against dicotyledenous plants or broad-leaved species.

In either pre-emergent (soil treatment) or post-emergent (foliar) application the compounds of the invention are superior to the prior art compounds in their selectivity for weed grasses in graminaceous crops. As demonstrated by the examples given at the end of this description, application of the quantity of compound necessary to kill or severely damage weed grasses such barnyard grass or giant foxtail does not injure rice or sorghum.

The compounds of formula (2) may be used on their own to inhibit the growth of, severely damage, or kill plants but are preferably used in the form of a composition comprising a compound of the invention in admixture with an inert carrier comprising a solid or liquid diluent.

Therefore, in yet a further aspect the invention provides plant growth inhibiting, plant damaging, or plant killing compositions comprising a compound of formula (2) as hereinbefore defined and an inert carrier therefor.

The compositions of the invention may comprise, in addition to one or more compounds of the invention, one or more compounds not of the

invention but which possess biological activity. For example, as herein before indicated the compounds of the invention are in general substantially more effective against monocotyledonous plants or grass species than against dicotyledonous plants or broad-leaved species. As a result, in certain applications the herbicidal use of the compounds of the invention alone may not be sufficient ot protect a crop.

Accordingly in yet a still further embodiment the invention provides a herbicidal composition comprising a mixture of at least one herbicidal compound of Formula (2) as hereinbefore defined with at least one other herbicide.

The compounds of formula (2) may be used on their own to regulate the growth of plants but in general are preferably used in the form of a composition comprising a compound of the invention in admixture with a carrier comprising a solid or liquid diluent.

Therefore, in a still further aspect the invention provides plant growth regulating compositions comprising a compound of Formula (2) as hereinbefore defined and an inert carrier therefor.

The compositions of the present invention may be in the form of solids, liquids or pastes. The compositions include both dilute compositions which are ready for immediate use and concentrated compositions which may require dilution before use. Therefore, the concentration of the active ingredient in the compositions of the present invention will vary depending on the type of formulation and whether the composition is ready for use such as, for example, a dust formulation or an aqueous emulsion or whether the composition is a concentrate such as, for example, an emulsifiable concentrate or a wettable powder, which is suitable for dilution before use. The present invention includes both types of composition, accordingly the

compositions to the present invention comprise from 1ppm to 99% by weight of active ingredient.

The solid compositions may be in the form of powders, dusts, pellets, grains and granules wherein the active ingredient is mixed with a solid diluent. Powders and dusts may be prepared by mixing or grinding the active ingredient with a solid carrier to give a finely divided composition. Granules, grains and pellets may be prepared by bonding the active ingredient to a solid carrier, for example, by coating or impregnating the preformed granular solid carrier with the active ingredient or by agglomeration techniques.

Examples of solid carriers include: mineral earths and clays such as, for example, kaolin, bentonite, kieselguhr, Fuller's earth, Attaclay, diatomaceous earth, talc, chalk, dolomite, limestone, lime, calçium carbonate, powdered magnesia, magnesium oxide, magnesium sulfate, gypsum, calcium sulfate, pyrophyllite, silicic acid, silicates and silica gels; fertilizers such as, for example, ammonium sulfate, ammonium phosphate, ammonium nitrate and urea; natural products of vegetable origin such as, for example, grain meals and flours, bark meals, wood meals, nutshell meals and cellulosic powders; and synthetic polymeric materials such as, for example, ground or powdered plastics and resins.

Alternatively, the solid compositions may be in the form of dispersible or wettable dusts, powders, granules or grains wherein the active ingredient and the solid carrier are combined with one or more surface active agents which act as wetting, emulsifying and/or dispersing agents to facilitate the dispersion of the active ingredient in liquid.

Examples of surface active agents include those of the cationic,

anionic and non-ionic type. Cationic surface active agents include quaternary ammonium compounds, for example, the long chain alkylammonium salts such as cetyltrimethylammonium bromide. Anionic surface active agents include: soaps or the alkali metal, alkaline earth metal and ammonium salts of fatty acids; the alkali metal, alkaline earth metal and ammonium salts of ligninsulfonic acid; the alkali metal, alkaline earth metal and ammonium salts of arylsulfonic acids including the salts of naphthalenesulfonic acids such as butylnaphthalenesulfonic acid, the di- and tri- isopropylnaphthalenesulfonic acids, the salts of the condensation products of sulfonated naphthalene and naphthalene derivatives with formaldehyde, the salts of the condensation products of sulfonated naphthalene and naphthalene derivatives with phenol and formaldehyde, and the salts of alkylarylbenzenesulfonic acids such as dodecylbenzenesulfonic acid; the alkali metal, alkaline earth metal and ammonium salts of the long chain mono esters of sulfuric acid or alkylsulfates such as laurylsulfate and the mono esters of sulfuric acid with fatty alcohol glycol ethers. Nonionic surface active agents include: the condensation products of ethylene oxide with fatty alcohols such as oleyl alcohol and cetyl alcohol; the condensation products of ethylene oxide with phenols and alkylphenols such as isooctylphenol, octylphenol and nonylphenol; the condensation products of ethylene oxide with castor oil; the partial esters derived from long chain fatty acids and hexitol anhydrides, for example sorbitan monolaurate, and their condensation products with ethylene oxide; ethylene oxide/propylene oxide block copolymers; lauryl alcohol polyglycol ether acetal; and the lecithins.

The liquid compositions may comprise a solution or dispersion of the active ingredient in a liquid carrier optionally containing one or

more surface active agents which act as wetting, emulsifying and/or dispersing agents. Examples of liquid carriers include: water; mineral oil fractions such as, for example, kerosene, solvent naphtha, petroleum, coal tar oils and aromatic hydrocarbons such as, for example, paraffin, cyclohexane, toluene, the xylenes, tetrahydronaphthalene and alkylated naphthalenes; alcohols such as, for example, methanol, ethanol, propanol, isopropanol, butanol, cyclohexanol and propylene glycol; ketones such as, for example, cyclohexanone and isophorone; and strongly polar organic solvents such as, for example, N,N-dimethylformamide, dimethylsulfoxide, N-methylpyrrolidone and sulfolane.

A preferred liquid composition comprises an aqueous suspension, dispersion or emulsion of the active ingredient which is suitable for application by spraying, atomizing or watering. Such aqueous compositions are generally prepared by mixing concentrated compositions with water. Suitable concentrated compositions include emulsion concentrates, pastes, oil dispersions, aqueous suspensions and wettable powders. The concentrates are usually required to withstand storage for prolonged periods and after such storage to be capable of dilution with water to form aqueous preparations which remain homogeneous for a sufficient time to enable them to be applied by conventional spray equipment. The concentrates conveniently contain from 20 to 99%, preferably 20 to 60%, by weight of active ingredient.

Emulsion or emulsifiable concentrates are conveniently prepared by dissolving the active ingredient in an organic solvent containing one or more surface active agents used in the formulation and the salts

generated in situ by the use of the appropriate organic or inorganic base.

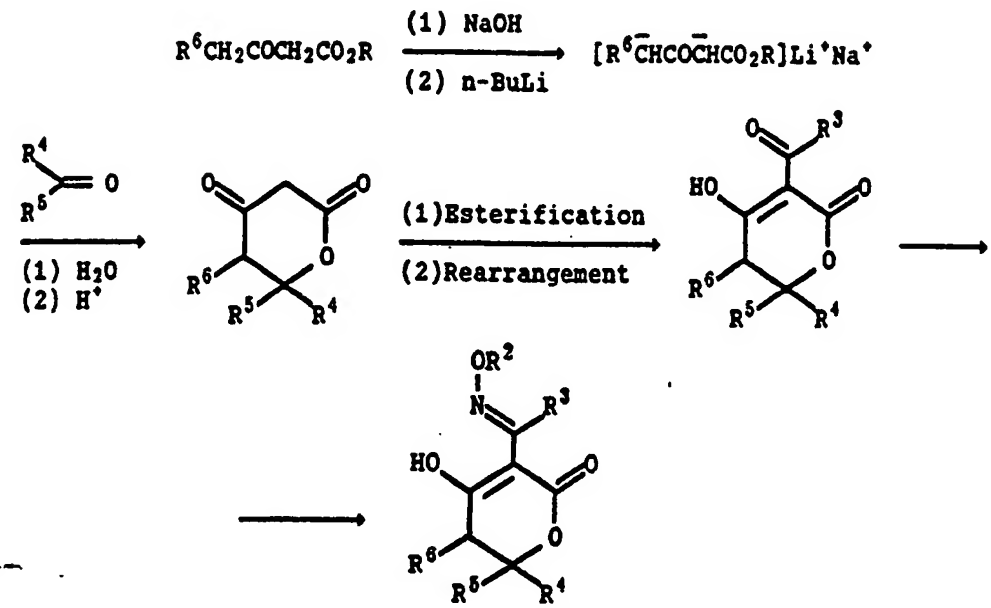
The mode of application of the compositions of the invention will depend to a large extent on the type of composition used and the facilities available for its application. Solid compositions may be applied by dusting or any other suitable means for broadcasting or spreading the solid. Liquid compositions may be applied by spraying, atomizing, watering, introduction into the irrigation water, or any other suitable means for broadcasting or spreading the liquid.

The rate of application of the compounds of the invention will depend on a number of factors including, for example, the compound chosen for use, the identity of the plants whose growth is to be inhibited, the formulations selected for use and whether the compound is to be applied for foliage or root uptake. As a general guide, however, an application rate of from 0.005 to 20 kilograms per hectare is suitable while from 0.01 to 5.0 kilograms per hectare may be preferred.

The compounds of this invention are prepared from the dianion of a substituted acetoacetate by ester condensation with an appropriate ketone (cf. Huckin S.N.,and Weiler, L., Can. J. Chem., 1974, 52, 2157) followed by hydrolysis and cyclization to 5-substituted 4-hydroxy-5,6-dihydro-2H-pyran-2-ones (Scheme 1 below). The hydroxypyranones can also be obtained by customary methods described in the literature. The 6,6-disubstituted pyran-2-ones thus obtained are acylated at the 3-position, by a Fries rearrangement reaction, and the acylated derivatives reacted with alkoxyamines to afford derivatives of the general formula (2).

Esterification of a vinylogous carboxylic acid in (2), (3), (4) or (5) provides further herbicidal and growth regulating derivatives. Neutralization of the vinylogous carboxylic acid in (2), (3), (4) or 5

provides further herbicidal and growth regulating derivatives where in R^1 is an inorganic or an organic cation.



Scheme 1

General Procedure for Preparation of Examples of Compounds of the Invention

(a) Synthesis of the Pyran-2,4-diones

Method A

To a stirred solution of the sodium salt of (the substituted) methyl or ethyl acetoacetate [*ca.* 55 mmol, either preformed or made *in situ* from (the substituted) methyl or ethyl acetoacetate (55 mmol) and sodium hydride (55 mmol) according to the method of Huckin, S.N., and Weiler, L., *Can. J. Chem.*, 1974 **52**, 2157] in dry tetrahydrofuran (50 ml) under nitrogen and cooled to 0°C, was added dropwise a solution of n-butyllithium (21.2 ml, 2.6M in hexane, 55 mmol). After 1 h the mixture was treated with an appropriate ketone (50 mmol) (solid ketones were dissolved in tetrahydrofuran prior to addition) and left stirring at 0°C

for 120 min before being quenched with methanol (2.4 ml, 60 mmol). After addition of further methanol (20 ml) and water (10 ml) [and in certain instances acid; e.g. acetic acid (3.2 ml, 56 mmol) was added] the mixture was boiled for ca. 30 min then diluted further with water (40 ml) and concentrated (to ca. 40 ml) at reduced pressure. Upon cooling and addition of water (ca. 150 ml) the mixture was extracted with ether (2 x 100 ml). The ether extracts were washed with water (50 ml) and the combined aqueous phases were acidified to pH 1-2 with conc. hydrochloric acid and extracted with ether (100 ml). (At this stage of some reactions a first crop of the pyrandione crystallized from the ether solution and was recovered by filtration). The ether solution was then evaporated and residual water removed from the product mixture by azeotropic distillation with ethanol/benzene and then with benzene. The residue was either chromatographed (SiO_2, dichloromethane) or, in some instances, crystallization of the pyrandione was achieved by diluting a concentrated benzene solution (ca. 20 ml) of the residue cautiously with cyclohexane to a faint turbidity, and then stirring vigorously. When crystallization ensued, the mixture was cautiously diluted with more cyclohexane (ca. 20 ml) and stirred for a further 4 h, after which the precipitate was collected and washed with cyclohexane/benzene (4:1) to afford the pyrandione.

Method B

A solution of n-butyllithium (45 ml, 2.45M in hexane, 110 mmol) was added to a stirred solution of diisopropylamine (15.6 ml, 111 mmol) in tetrahydrofuran (50 ml) maintained at 0°C under argon. The stirring was continued for 15 min at room temperature; the mixture was then chilled in ice. The substituted methyl or ethyl acetoacetate (52.5 mmol) was

then added and the resultant mixture stirred at 0° for 30 min; whereupon an appropriate ketone (50 mmol dissolved in the minimum quantity of tetrahydrofuran to form a homogeneous solution) was added and stirring continued for an additional 90 min (or until the reaction mixture paled to light orange or yellow) before quenching with methanol (4.8 ml, 120 mmol). The reaction mixture was then worked up as in Method A to give the pyrandione.

(b) Acylation of Pyrandiones

To a stirred solution of the pyrandione (6.10 mmol) and DBU [1,8-diazabicyclo(5.4.0)-7-undecene] (0.99 g, 6.5 mmol) in toluene (20 ml) at 0° was added an appropriate acyl chloride (6.6 mmol) and the mixture stirred at 0°C for 2 h, then at room temperature for 24 h. Dilution with water (50 ml) and toluene (30 ml) and shaking the mixture gave an organic phase which was quickly washed with 5% hydrochloric acid, dried (sodium sulfate) and evaporated *in vacuo*. The residue and 4-dimethylaminopyridine (40 mg, 0.3 mmol) were heated under reflux in toluene (10 ml) for 3 h (or until thin layer chromatography showed that the reaction was complete) and then the toluene was removed *in vacuo* and the residue chromatographed [SiO_2, dichloromethane:light petroleum (b.p. 40-60°C): ethyl acetate (4:4:1)] to give the C-acylated compound.

(c) Oximation of Acylated Compounds.

A mixture of the *C*-acylated compound (3.75 mmol), the appropriate *O*-substituted hydroxylamine hydrochloride (4.00 mmol), triethylamine (0.41 g, 4.0 mmol) and methanol (5 ml) was stirred at room temperature for 48 h, then poured into water (50 ml). Acidification of the mixture to pH 4 with 5M hydrochloric acid, extraction with diethyl ether or

ethyl acetate (2 x 50 ml), evaporation of the organic phase and chromatography [SiO_2, dichloromethane or dichloromethane:light petroleum (b.p. 40-60°C:ethyl acetate (4:4:1)] of the residue then afforded examples of compounds of the invention (2)

The compounds made using Method A include those in the following Examples (1-19).

Example 1

Preparation of 8-[1-(ethoxyimino)butyl]-9-hydroxy-10-methyl-6-oxaspiro[4.5]dec-8-en-7-one

(a) 10-Methyl-6-oxaspiro[4.5]dec-7,9-dione

Sodium hydride (1.65g, 80% in oil, *ca* 55 mmol) was reacted with methyl propionylacetate (6.5g, 50 mmol) in tetrahydrofuran (45 ml) at 10-15°C. Addition of *n*-butyllithium (22 ml, 2.5 M in hexane) at 0°C followed by cyclopentanone (4.45 ml, 50 mmol) and work-up according to Method A described above gave the pyrandione as a white powder (3.6g, 39%), m.p. 141-143°C. Mass spectrum m/z 183 (M+1). ^1H n.m.r. δ ($CDCl_3$) 3.35, s, 2H; 2.36, broad s, $CH_3\underline{CH}$; 1.3-2.1, m, 8H; 1.02, broad s, $\underline{CH_3}CH$.

(b) 8-Butyryl-9-hydroxy-10-methyl-6-oxaspiro[4.5]dec-7,9-dione

The dione (1.48g), 8 mmol) was esterified with butyryl

chloride (1.1g, 10 mmol) in the presence of DBU (1.5g) and the O-butyryl ester intermediate was rearranged by heating with 4-dimethylaminopyridine, as described in Part (b) of the general procedure above to give the C-acylated compound (1.7g, 81%) as a light brown oil. Mass spectrum 253 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.14, broad, OH; 3.01, t, J 7Hz, $\underline{CH_2}CH_2CH_3$; 2.40, q, J 7.5Hz, $CH_3\underline{CH}$, 2.35-1.2, complex, 11H, 0.89, multiplet, $CH_2CH_2\underline{CH_3}$ and $CH\underline{CH_3}$. The crude product was used in the next step without additional purification.

(c) 8-[1-Ethoxyimino)butyl]-9-hydroxy-10-methyl-6-oxaspiro-[4.5]dec-8-en-7-one

The acylated compound (1.1g) obtained as described in (b) was reacted with ethoxyamine hydrochloride (0.5 g) in the presence of triethylamine (0.5 g) as described in Part (c) of the general procedure to give the oxime ether (1c) (0.73 g, 60%) as a pale yellow oil after chromatographic purification over silica gel. Mass spectrum m/z 296 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.7, broad s, OH; 4.14, q, J 7Hz, $O\underline{CH_2}CH_3$; 2.98, broad t, J 7.5Hz, $\underline{CH_2}CH_2CH_3$; 2.43, q, J 8Hz, $\underline{CH}CH_3$; 2.1-0.9, multiplet, 19H.

Example 2

Preparation of 8-[1-((2-chloro-2-propenyl)oxyimino)butyl]-9-hydroxy-10-methyl-6-oxaspiro[4.5]dec-8-en-7-one

(c) The acylated compound 1(c) (1.1 g) was reacted with 2-chloro-2-propenyloxyamine hydrochloride (0.7 g) in the presence of triethylamine (0.5 g) as described in Part (c) of the general procedure above to give the oxime ether 2(c) as a pale yellow oil (0.84 g, 62%) after chromatographic purification over silica gel. Mass spectrum 342 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 13.9, broad, OH; 5.46, s, $C(Cl)=CH_2$; 4.61, s, CH_2-C(Cl); 2.98, broad t, *J* 7Hz, $\underline{CH_2}CH_2CH_3$; 2.24, q, *J* 7.5Hz; $\underline{CH}CH_3$; 2.2-1.5, broad, 10H; 1.30, d, *J* 7.5Hz, $CH\underline{CH_3}$; 0.98, t, *J* 7Hz, $CH_2CH_2\underline{CH_3}$.

Example 3

Preparation of 8-[1-(ethoxyimino)butyl]-10-ethyl-9-hydroxy-6-oxaspiro[4.5]dec-8-en-7-one

(a) 10-Ethyl-6-oxaspiro[4.5]dec-7,9-dione

Sodium hydride (1.65 g, 80% in oil, *ca* 55 mmol) was reacted with ethyl butyrylacetate (7.9 ml, 50 mmol) in tetrahydrofuran (40 ml). Addition of *n*-butyllithium (22 ml, 2.5M in hexane) at 0°C followed by cyclopentanone (4.43 ml, 50 mmol) and work-up according to Method A described above gave the pyrandione as a white powder (1.8 g, 18%) m.p. 111-113°C. Mass spectrum m/z 197 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 3.37, broad s, 2H; 2.38, broad t, *J* 7.5Hz, $CH_3CH_2\underline{CH}$; 1.3-2.2, m, 10H; 0.97, broad t, *J* 7Hz, $\underline{CH_3}CH_2CH$.

(b) 8-Butyryl-10-ethyl-9-hydroxy-6-oxaspiro[4.5]dec-7,9-dione

The pyrandione (1.55 g, 8 mmol) was acylated with butyryl chloride (1.1 g, 10 mmol) in the presence of DBU (1.52 g) and the O-butyryl intermediate was rearranged by heating with 4-dimethylaminopyridine, as described in Part (b) of the general procedure above to afford the C-acylated compound (2.0 g, 95%) as a pale yellow oil. Mass spectrum 267 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.55, broad, OH; 2.86, t, J 7.5Hz, $\underline{CH_2}CH_2CH_3$; 2.4 - 1.2, complex, 13H; 0.86, overlapping t, J 7.5Hz, $CH_2CH_2\underline{CH_3}$ and $CH_2\underline{CH_3}$.

(c) 8-[1-(Ethoxyimino)butyl]-10-ethyl-9-hydroxy-6-oxaspiro[4.5]dec-8-en-7-one

The acylated compound obtained as described in 3(b) (0.8 g) was oximated with ethoxyamine hydrochloride (0.4 g) in the presence of triethylamine (0.4 g) as described in Part (c) of the general procedure above to afford the title compound 3(c) (0.5 g, 46%) as a pale yellow oil. Mass spectrum m/z 310 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 15.08, broad s, OH; 4.05, q, J 7.5Hz, $O\underline{CH_2}CH_3$; 3.2 - 2.65, multiplet, 2H, $\underline{CH_2}CH_2CH_3$; 2.6 - 1.3, complex, 13H; 1.35, t, J 7.5Hz, $OCH_2\underline{CH_3}$; 0.97, overlapping t, J 7Hz, $CH_2\underline{CH_3}$ and $CH_2CH_2\underline{CH_3}$.

Example 4

Preparation of 8-[1-((2-chloro-2-propenyl)oxyimino)butyl]-10-ethyl-9-hydroxy-3-methyl-6-oxaspiro[4.5]dec-8-en-7-one

(a) 10-Ethyl-3-methyl-6-oxaspiro[4.5]dec-7,9-dione

Sodium hydride (1.65 g, 80% in oil, *ca* 55 mmol) was reacted with ethyl butyrylacetate (7.9 ml, 50 mmol) in tetrahydrofuran (40 ml). Addition of *n*-butyllithium (22 ml, 2.5 M in hexane) at 0°C followed by 3-methylcyclopentanone (5.23 g, 55 mmol) and work up according to Method A described previously gave the pyrandione (4a) as a light brown waxy solid (2.4 g, 23%) mp 35-40°C. Mass spectrum m/z 211 (M+1). ^1H n.m.r. δ ($CDCl_3$) 3.36, broad s, 2H; 2.37, broad t, *J* 7.5Hz, $CH_3CH_2\underline{CH}$; 2.2 - 1.3, m, 12H; 0.98, broad t, *J* 7HZ, $\underline{CH_3}CH_2CH$, 0.95, broad d, *J* 7Hz, $CH\underline{CH_3}$.

(b) 8-butyryl-10-ethyl-9-hydroxy-3-methyl-6-oxaspiro[4.5]dec-8-en-7-one

The pyrandione (1.05 g, 5 mmol) was acylated with butyryl chloride (0.63 g, 6 mmol) in the presence of DBU (1.2 g) and the *O*-butyryl intermediate so obtained was rearranged by heating with 4-dimethylaminopyridine, as described in Part (b) of the general procedure above to give the C-acylated compound (1.18 g, 75%) as a light brown oil. Mass spectrum 281 (M+1). ^1H n.m.r. δ ($CDCl_3$) 14.14, broad, OH; 2.91, t, *J* 7.0Hz, $\underline{CH_2}CH_2CH_3$; 2.4 - 1.1, complex, 15H; 1.0 - 0.9, m, 9H. The crude product thus obtained was used without purification in the next preparation.

(c) 8-[1-((2-chloro-2-propenyl)oxyimino)butyl]-10-ethyl-9-hydroxy-3-methyl-6-oxaspiro[4.5]dec-8-en-7-one

The acylated compound obtained as described in (b) (0.74 g) was reacted with 2-chloro-2-propenyloxyamine hydrochloride (0.5 g) in the presence of triethylamine (0.4 g) as described in Part (c) of the general procedure above to give the oxime ether (4c) (0.71 g, 65%) as a pale yellow oil after purification by chromatography over silica gel. Mass spectrum m/z 371 (M+1). ^{1}H n.m.r. δ $CDCl_3$ 14.5, broad s, OH; 5.44, s, $C(Cl)=CH_2$; 4.61, s, CH_2-C(Cl); 2.96, t, J 7Hz, $\underline{CH}CH_2CH_3$; 2.4 - 0.9, m, 21H.

Example 5

Preparation of 3-[1-((2-chloro-2-propenyl)oxyimino)butyl]-4-hydroxy-5-methyl-1-oxaspiro[5.5]undec-3-en-2-one

(a) 5-Methyl-1-oxaspiro[5.5]undeca-2,4-dione

Cyclohexanone (51 mmol) was reacted with the dianion of ethyl propionylacetate, as described in Method B above. The pyrandione (4.1 g, 41%) crystallized from benzene/cyclohexane as a white powder m.p. 125-127°C. Mass spectrum m/z 197 (M+1).

(b) 3-Butyryl-4-hydroxy-5-methyl-1-oxaspiro[5.5]undec-3-en-2-one

The pyrandione (3.0 g, 15.3 mmol) was acylated with butyryl chloride (1.97 g, 18.5 mmol) in the presence of DBU (2.74 g), and the O-butyryl intermediate rearranged by heating

with 4-dimethylaminopyridine, as described in Part (b) of the general procedure above, to afford the C-acylated compound (3.55 g, 87%) as a pale yellow oil. Mass spectrum m/z 267 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 15.35, broad s, OH; 3.03, t, J 7Hz, $\underline{CH_2}CH_2CH_3$; 2.72 - 2.2, m, H5; 2.0 - 1.4, complex, 12H; 1.2, t, J 7Hz, $CH_2CH_2\underline{CH_3}$; 1.16, d, J 6Hz, CH_3.

(c) 3-[1-((2-chloro-2-propenyl)oxyimino)butyl]-4-hydroxy-5-methyl-1-oxaspiro[5.5]undec-3-en-2-one

The acylated compound obtained as described in 5(b) above (0.66 g, 2.5 mmol) was oximated with (2-chloro-2-propenyl)oxyamine hydrochloride (0.5 g, 3.5 mmol) in the presence of triethylamine (0.35 g) as described in Part (c) of the general procedure above, to afford the title compound 5(c) (0.52 g, 60%) as a mobile pale yellow oil. ^{1}H n.m.r. δ ($CDCl_3$) 15.72, broad, 1H; 5.42, s, 2H, $=CH_2$, 4.53, s, 2H OCH_2; 2.95, t, J 7Hz $\underline{CH_2}CH_2CH_3$; 2.45, q, J 6Hz, $CH_3\underline{CH}$; 2.2 - 1.35, complex 12H; 1.15, d, J 6Hz, $\underline{CH_3}CH$; 0.9, t, J 7Hz, $CH_2CH_2\underline{CH_3}$.

Example 6

(c) Preparation of 3-[-1((3-chloro-2-propenyl)oxyimino)butyl]-4-hydroxy-5-methyl-1-oxaspiro[5.5]undec-3-en-2-one

The acylated compound obtained as described in 5(b) above (0.53 g, 2 mmol) was reacted with 3-chloro-2-propenyloxyamine

hydrochloride (0.43 g, 3 mmol) (E/Z ratio about 1:1) in the presence of triethylamine (0.3 g, 3 mmol) as described in Part (c) of the general procedure. Following purification by chromatography on silica gel the product 6(c) (0.48 g, 68%) was obtained as a pale yellow oil. Mass spectrum m/z 356 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.4, broad s, OH; 6.6 - 5.8, m, $CH_2\underline{CH}=\underline{CH}Cl$; 4.8 - 4.4, m, $\underline{CH_2}CH=CHCl$; 2.92, t, $\underline{J}$ 7.5Hz, $\underline{CH_2}CH_2CH_3$; 2.24, q, $\underline{J}$ 7Hz; $CH_3\underline{CH}$; 2.1 - 1.4, m, 15H; 1.08, d, $\underline{J}$ 7Hz, $CH\underline{CH_3}$; 0.094, t, $\underline{J}$ 7.5Hz.

Example 7

Preparation of 3-[1-(ethoxyimino)butyl]-5-ethyl-4-hydroxy-9-methyl-1-oxaspiro[5.5]undec-3-en-2-one

(a) 5-Ethyl-9-methyl-1-oxaspiro[5.5]undec-2,4-dione

Ethyl butyrylacetate (7.9 ml, 50 mmol) was reacted with sodium hydride (1.65 g, 80% in oil, ca 55 mmol) in tetrahydrofuran. Addition of n-butyllithium (22 ml, 2.5M in hexane) at 0°C followed by 4-methylcyclohexanone (5.6 g, 50 mmol) and work-up according to Method A described above gave the pyrandione 7(a) as colourless crystals (3.1 g, 28%) m.p. 92 - 93°C. Mass spectrum m/z 225 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 3.35, broad s, 2H; 2.38, broad t, $\underline{J}$ 7.5Hz, $CH_3CH_2\underline{CH}$; 2.1 - 0.8, m, 17H.

(b) 3-Butyryl-5-ethyl-4-hydroxy-9-methyl-1-oxaspiro[5.5]undec-3-en-2-one

The pyrandione (2.2 g, 10 mmol) was acylated with butyryl chloride (1.2 g, 11 mmol) in the presence of DBU (1.67 g, 11 mmol) and the O-butyryl product was rearranged by heating with 4-dimethylaminopyridine as described in Part (b) of the general procedure to give the C-acylated compound 7(b) (2.4 g, 80%) as a light brown oil. Mass spectrum m/z 295 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.5, broad s, OH; 3.12, t, *J* 7.5Hz, $\underline{CH_2}CH_2CH_3$; 2.14, broad t, *J* 7Hz, $\underline{CH}CH_2CH_3$; 2.1 - 0.9, m, 22H. The crude product thus obtained was used without further purification in subsequent preparations.

(c) 3-[1-(Ethoxyimino)butyl]-5-ethyl-4-hydroxy-9-methyl-1-oxaspiro[5.5]undec-3-en-2-one

The acylated compound obtained as described in 7(b) (0.59 g) was oximated with ethoxyamine hydrochloride (0.3 g) in the presence of triethylamine (0.3 g) as described in Part (c) of the general procedure above to give the oxime ether 7(c) (0.51 g, 76%) as a pale yellow oil after chromatography over silica gel. Mass spectrum m/z 338 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.4, broad, OH; 4.12, q, *J* 7Hz $O\underline{CH_2}CH_3$; 3.2, broad t, *J* 7Hz, $\underline{CH_2}CH_2CH_3$; 2.3 - 0.9, m, 25H.

Example 8

Preparation of 3-[1-((2-propenyl)oxyimino)butyl]-5-ethyl-4-hydroxy-9-methyl-1-oxaspiro[5.5]undec-3-en-2-one

(c) The acylated compound obtained as described in 7(b) (0.59 g, 20 mmol) was reacted with (2-propenyl)oxyamine hydrochloride (0.33 g, 30 mmol) in the presence of triethylamine (0.3 g, 30 mmol) as described in Part (c) of the general procedure to give the oxime ether 8(c) (0.53 g, 76%) as a pale yellow oil following chromatographic purification over silica gel. ^{1}H n.m.r. δ ($CDCl_3$) 14.7, broad s, OH; 6.1 - 5.0, m, $CH_2\underline{CH}{=}\underline{CH_2}$; 4.40, d, J 6Hz, $\underline{CH_2}$-$CH{=}CH_2$; 2.93, broad t, J 7.5Hz, $\underline{CH_2}CH_2CH_3$; 2.20, broad t, J 7Hz, $\underline{CH}CH_2CH_3$; 1.8 - 0.8, m, 22H.

Example 9

Preparation of 8-[1-(ethoxyimino)butyl]-9-hydroxy-10-methyl-6-oxa-2-thiaspiro[4.5]dec-8-en-7-one

(a) 10-Methyl-6-oxa-2-thiaspiro[4.5]dec-7,9-dione

Sodium hydride in oil (1.65 g, 80% in oil ca 55 mmol) was reacted with methyl propionylacetate (6.5 g, 50 mmol) in tetrahydrofuran (40 ml) at 5-10°C. Addition of n-butyllithium (22 ml, 2.5M in hexane) at 0°C followed be tetrahydrothiophen-3-one (5.1 g, 50 mmol) and work up according to Method A described above gave the pyrandione 9(a) as a fawn powder (4.7 g, 47%), m.p. 120-122°C. Mass spectrum m/z 201 (M+1). ^{1}H n.m.r. δ [$CDCl_3$+10%$(CD_3)_2SO$] 5.14, s, CO-$\underline{CH}{=}$C(OH); 3.4 - 1.6, m, 7H; 1.30, d, J 7Hz, $CH\underline{CH_3}$.

(b) 8-Butyryl-9-hydroxy-10-methyl-6-oxa-2-thiaspiro[4.5]dec-8-en-7-one

The pyrandione (4.0 g, 20 mmol) was reacted with butyryl chloride (2.4 g, 22 mmol) in the presence of DBU (3.3 g, 22 mmol) to give the O-butyryl ester which was rearranged by heating with 4-dimethylaminopyridine as described in Part (b) of the general procedure to give the C-acylated compound (4.2 g, 78%) as a brown oil. Mass spectrum m/z 271 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.0, broad, OH; 3.4 - 1.5, m, 11H, 1.3, broad d, *J* 7Hz, $CH\underline{CH_3}$; 1.0, broad t, *J* 7Hz, $CH_2CH_2\underline{CH_3}$. The crude product was used without further purification in the preparation of oxime ethers.

(c) 8[-(Ethoxyimino)butyl]-9-hydroxy-10-methyl-6-oxa-2-thiaspiro[4.5]dec-8-en-7-one

The acylated compound obtained as described in 9(b) (0.54 g, 20 mmol) was reacted with ethoxyamine hydrochloride (0.25 g, 25 mmol) in the presence of triethylamine (0.25 g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether 9(c) as a light brown oil (0.42 g, 68%) following chromatography over silica gel. Mass spectrum m/z 314 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.2, broad, OH: 4.06, q, *J* 7Hz, $O\underline{CH_2}CH_3$; 3.3 - 1.8, m, $\underline{CH_2}SCH_2$, $CH_3\underline{CH}$ and $\underline{CH_2CH_2}CH_3$; 1.3 overlapping t and d, *J* 7Hz, $\underline{CH_3}CH_2CH_2$ and $OCH_2\underline{CH_3}$; 0.9, broad t, $CH\underline{CH_3}$.

EXAMPLE 10

(c) Preparation of 8[1-((2-propenyl)oxyimino)butyl]-9-hydroxy-10-methyl-6-oxa-2-thiaspiro[4.5]dec-8-en-7-one

The acylated compound 9(b) (0. 54 g, 20 mmol) described previously was reacted with 2-propenyloxyamine hydrochloride (0.28, 25 mmol) in the presence of triethylamine as described in Part (c) of the general procedure to give the oxime ether (0.31 g, 48%) as a light brown oil following purification by chromatography over silica gel. Mass spectrum m/z 326 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 15.1, broad s, OH; 6.6 - 4.8, m, CH_2-CH=CH_2; 4.5, d, J 6Hz, $CH_2CH=CH_2$; 3.4 - 1.4, m, 11H; 1.2, d, J 7.5, $CHCH_3$; 0.92, broad t, J 7.5Hz, $CH_2CH_2CH_3$.

Example 11

(c) Preparation of 8[1-((2-chloro-2-propenyl)oxyimino)butyl]-9-hydroxy-10-methyl-6-oxa-2-thiaspiro[4.5]dec-8-en-7-one

The acylated compound 9(b) (0.54 g, 20 mmol) previously described was reacted with 2-chloro-2-propenyloxyamine hydrochloride (0.36 g, 25 mmol) in the presence of triethylamine (0.25 g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (0.43 g, 60%) as a light brown oil after purification on silica gel. Mass spectrum, m/z, 361 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 15.1, broad s, OH; 5.7, s,

CH_2-C(Cl)=$\underline{CH_2}$; 4.7, s, $\underline{CH_2}$-C(Cl)=CH_2; 3.5 - 1.6, m, 11H; 1.48, d, $\underline{J}$ 7Hz, CH$\underline{CH_3}$; 1.1, broad t, $\underline{J}$ 7Hz, $CH_2CH_2\underline{CH_3}$.

Example 12

Preparation of 9-[1-(ethoxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-2-thiaspiro[5.5]undec-8-en-7-one

(a) 11-Methyl-7-oxa-2-thiaspiro[5.5]undec-8,10-dione

Sodium hydride in oil (1.65 g, 80% in oil, ca 55 mmol) was reacted with methyl propionylacetate (6.5 g, 50 mmol) in tetrahydrofuran (50 ml) at 5-10°C. Addition of n-butyllithium (22 ml, 2.5 M in hexane) at 0°C followed by tetrahydrothiopyran-3-one (5.9 g, 50 mmol) and work up according to Method A previously described above gave the pyrandione (5.7 g, 53%) as buff crystals m.p 190°C (dec). Mass spectrum, m/z 215 (M+1). ^{1}H n.m.r. δ ($CDCl_3$+10%$(CD_3)_2SO$) 10.8, broad, OH; 5.20, s, CO-$\underline{CH}$=C(OH); 3.6 - 1.4, m, 9H; 1.19, d, $\underline{J}$ 7Hz, CH$\underline{CH_3}$.

(b) 9-Butyryl-10-hydroxy-11-methyl-7-oxa-2-thiaspiro[5.5]undec-8-en-7-one

The pyrandione 12(a) (2.14 g, 10 mmol) was acylated with butyryl chloride (1.2 g, 11 mmol) in the presence of DBU (1.67 g, 11 mmol) and the O-butyryl ester was rearranged by heating with 4-dimethylaminopyridine as described in Part (b) of the general

procedure to give the C-acylated compound (2.61 g, 92%) as a light brown oil. Mass spectrum, m/z, 285 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 12.8, broad, OH; 3.34, q, J 7.5Hz, $CH_3\underline{CH}$; 3.08, t, J 7Hz, $\underline{CH_2}CH_2CH_3$; 2.74, broad s, S-CH_2; 2.6 - 1.4, m, 10H; 1.24, d, J 7Hz, $\underline{CH_3}CH$; 0.94, t, J 7Hz, $CH_2CH_2\underline{CH_3}$. The crude 12(b) was used without further purification in subsequent preparations.

(c) 9-[1-(Ethoxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-2-thiaspiro[5.5]undec-8-en-7-one

The acylated compound 12(b) (0.57 g, 20 mmol) described above was reacted with ethoxyamine hydrochloride (0.25 g, 25 mmol) in the presence of triethylamine (0.25 g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (0.52 g, 80%) as a pale brown oil following purification upon silica gel. Mass spectrum, m/z, 328 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.9, broad, OH; 4.1, q, J 7Hz, $O\underline{CH_2}CH_3$; 3.5- 1.4, m, 12H; 1.31, t, J 7Hz, $OCH_2\underline{CH_3}$; 1.24, d, J 7Hz, $CH\underline{CH_3}$; 0.98, broad t, J 7Hz, $CH_2CH_2\underline{CH_3}$.

Example 13

(c) Preparation of 9-[1-((2-chloro-2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-2-thiaspiro[5.5]undec-8-en-7-one

The acylated compound 12(b) (0.57 g, 20 mmol) described previously was reacted with 2-chloro-2-propenyloxyamine

hydrochloride (0.36 g, 25 mmol) in the presence of triethylamine (0.25 g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (6.4 g, 85%) as a pale yellow oil after chromatographic purification over silica gel. Mass spectrum, m/z 374 (M+1). ^{1}H n.m.r., 14.7, broad, OH; 5.55, s, CH_2-C(Cl)=$\underline{CH_2}$; 4.60, s, $\underline{CH_2}$-C(Cl)=CH_2; 3.6 - 1.4, m, 13H; 1.28, d, *J* 7Hz, $\underline{CH_3}$CH; 0.94, t, *J* 7Hz, $CH_2CH_2\underline{CH_3}$.

Example 14

(c) Preparation of 9-[1-((3-chloro-2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-2-thiaspiro[5.5]undec-8-en-7-one

The acylated compound 12(b) (0.57 g, 20 mmol) described previously was reacted with 3-chloro-2-propenyloxyamine hydrochloride (0.36 g, 25 mmol) in the presence of triethylamine (0.25 g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (5.7 g, 76%) as a light brown oil after chromatography over silica gel. Mass spectrum, m/z, 374 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.3, broad, OH; 6.5 - 5.8, m, $CH_2\underline{CH}$=$\underline{CH}$Cl; 4.8 - 4.4, m, $\underline{CH_2}$CH=CHCl; 3.4, q, *J* 7Hz, $CH_3\underline{CH}$; 3.2 - 1.4, m, 12H; 1.22, d, *J* 7Hz, $\underline{CH_3}$CH; 0.92, broad t, *J* 7Hz, $CH_2CH_2\underline{CH_3}$.

Example 15

Preparation of 9[1-(ethoxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one

(a) 11-Methyl-7-oxa-3-thiaspiro[5.5]undec-8,10-dione

Sodium hydride in oil (1.65 g, 80% in oil, ca 55 mmol) was reacted with methyl propionylacetate (6.5 g, 50 mmol) in tetrahydrofuran (45 ml) at 5-10°C to form the sodium salt. Addition of n-butyllithium (22 ml, 2.5M in hexane) at 0°C gave the dianion which was reacted with tetrahydrothiopyran-4-one (5.9 g, 50 mmol) and worked up according to Method A described previously to give the pyrandione (5.5 g, 51%) as a white powder, m.p. 142-145°C. Mass spectrum, m/z, 215 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 3.40, s, $COCH_2CO$; 3.38 - 1.5, m, 9H; 1.22, d, J 7Hz, $CHCH_3$.

(b) 9-Butyryl-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one

The pyrandione 15(a) (4.3 g, 20 mmol) was reacted with butyryl chloride (2.4 g, 22 mmol) in the presence of DBU (3.34 g, 22 mmol) and the O-butyryl ester obtained was rearranged by heating with 4-dimethylaminopyridine as described in Part (b) of the general procedure to give the C-acylated compound 15(b) (5.07 g, 89%) as a light brown oil. Mass spectrum, m/z, 285 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 15.2, broad, OH; 3.2 - 1.4, m, 13H,

1.29, d, J 7Hz; 0.96, t, J 7.5Hz, $CH_2CH_2\underline{CH_3}$. Crude 15(b) was used without additional purification.

(c) 9-[1-(Ethoxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one

The triketone 15(b) (0.57 g, 20 mmol) described previously was reacted with ethoxyamine hydrochloride (0.25 g, 25 mmol) in the presence of triethylamine (0.25 g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (0.49 g, 75%) as a pale yellow oil after purification by chromatography over silica gel. Mass spectrum, m/z, 328 (M+1). ^1H n.m.r. δ ($CDCl_3$) 14.5, broad, OH; 3.6, q, J 7Hz, $O\underline{CH_2}CH_3$; 2.6 - 1.06, m, 13H; 1.0 - 0.48, overlapping t, d and t, $OCH_2\underline{CH_3}$, $CH\underline{CH_3}$ and $CH_2CH_2\underline{CH_3}$.

Example 16

(c) Preparation of 9-[1-((3-chloro-2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one

The triketone 15(b) (0.57 g, 20 mmol) described above was reacted with 3-chloro-2-propenyloxyamine hydrochloride (0.36 g, 25 mmol) in the presence of triethylamine (0.25 g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (0.49 g, 65%) as a pale yellow oil after chromatography over

silica gel. Mass spectrum, m/z, 374 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.6, broad, OH; 6.3 - 5.7, m, CH_2-<u>CH</u>=<u>CH</u>Cl; 4.42, d, <u>J</u> 6Hz, <u>CH_2</u>CH=CHCl; 3.2 - 1.35, m, 13H; 1.15, d, 7Hz, CH<u>CH_3</u>; 0.97, broad t, <u>J</u> 7Hz, CH_2CH_2<u>CH_3</u>.

Example 17

(c) Preparation of 9-[1-((2-chloro-2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one

The triketone 15(b) (0.57 g, 20 mmol) described above was reacted with 2-chloro-2-propenyloxyamine hydrochloride (0.36 g, 25 mmol) in the presence of triethylamine (0.25 g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (0.51 g, 68%) as a pale yellow oil after chromatographic purification over silica gel. Mass spectrum, m/z, 374 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 13.8, broad s, OH; 5.5, s, CH_2-C(Cl)=<u>CH_2</u>; 4.59, s, <u>CH_2</u>-C(Cl)=CH_2; 3.3 - 2.34, m, 13H; 1.22, d, <u>J</u> 7Hz, CH<u>CH_3</u>; 0.98, broad t, <u>J</u> 7.5Hz, CH_2CH_2<u>CH_3</u>.

Example 18

(c) Preparation of 9-[1-((2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one

The acylated diketone 15(b) (0.57 g, 20 mmol) previously

described was reacted with 2-propenyloxyamine hydrochloride (0.27 g, 22 mmol) in the presence of triethylamine (0.25g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (0.52g, 76%) as a pale yellow oil after purification by chromatography over silica gel. Mass spectrum, m/z, 340 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.7, broad, OH; 6.2 - 5.1, m, $CH_2\underline{CH{=}CH_2}$; 4.50, d, J 6Hz, $\underline{CH_2}CH{=}CH_2$; 3.2 - 1.3, m, 13H; 1.14, d, J 7Hz, $CH\underline{CH_3}$; 0.97, broad t, J 7Hz, $CH_2CH_2\underline{CH_3}$.

Example 19

(c) Preparation of 9-[1-((2-propynyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one

The triketone 15(b) (0.57 g, 20 mmol) previously described was reacted with 2-propynyloxyamine hydrochloride (0.27 g, 22 mmol) in the presence of triethylamine (0.25g, 25 mmol) as described in Part (c) of the general procedure to give the oxime ether (0.49g, 73%) as a pale yellow oil following purification by chromatography over silica gel. Mass spectrum, m/z, 338 (M+1). ^{1}H n.m.r. δ ($CDCl_3$) 14.3, broad, OH; 4.61, d, J 3Hz, $\underline{CH_2}C{\equiv}CH$; 3.4 - 1.3, m, 14H; 1.21, d, J 7Hz, $CH\underline{CH_3}$; 0.91, broad t, J 7Hz, $CH_2CH_2\underline{CH_3}$.

The pre-emergent herbicidal activities of the compounds of the invention were assessed by the following procedure:

Seeds of each of the test species were sown 5 mm deep in pre-sterilized soil in square plastic pots approximately 6cm x 7cm with an appropriate number of seeds per pot to avoid overcrowding and allow satisfactory plant development. The pots were then placed at randomised positions in trays 30cm x 34cm so that each tray contained one of each test species.

The required quantity of the test compound was dissolved in acetone and the acetone solution dispersed in water to give a spray liquid volume equivalent to 1000 l/ha.

Two trays were sprayed with the test compound for each application rate using a flat fan even swathe nozzle. One tray for each ten chemical treatments was sprayed with acetone/water only and was included in the remainder of the test procedure to act as control. All the trays were placed in a glasshouse, lightly watered with an overhead spray to initiate germination and then spray irrigated as required for optimum plant growth. After three weeks the trays were removed from the greenhouse and the effect of the treatment was assessed. The assessments were on a 1-10 scale, where 0 = no effect and 10 = plants dead.

The test species and results are shown for the compounds of Examples 1 - 2 in Tables 1 - 2 respectively.

The post-emergent herbicidal activities of the compounds of the invention were assessed by the following procedures:

Seeds of each of the test species were sown 5mm deep in pre-sterilized soil in square plastic pots approximately 6 cm x 7cm with an appropriate number of seeds per pot to avoid overcrowding and allow satisfactory plant development. The pots were then placed at randomised positions in trays 30cm x 34cm so that each tray contained one of each test species.

All they trays were placed in a glasshouse, lightly watered with an overhead spray to initiate germination and then spray irrigated as required for optimum plant growth. After the plants had grown to a height of 10 to 12.5cm the required quantity of the test compound was dissolved in acetone and the acetone solution dispersed in water to give a spray liquid volume equivalent to 1000 l/ha.

Two trays were sprayed with the test compound for each application rate using a flat fan even swathe nozzle. One tray for each ten chemical treatments was sprayed with acetone/water solution only and was included in the remainder of the test procedure to act as control.

The treated trays were then returned to the greenhouse. After three weeks post-treatment the effect of the treatment was visually assessed. The assessments were on a 0 - 10 scale, where 0 = no effect and 10 = plants dead.

The test species and results are shown for the compounds of Examples 1 - 19 in the Tables which follow.

HERBICIDAL ACTIVITY OF COMPOUND 1(c)

	MEAN HERBICIDAL RATING			
	PRE-EMERGENT Application Rate (Kg/Ha)		POST-EMERGENT Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	8	10	10	10
Crabgrass	3	5	5	7
Cheat grass	-	-	-	-
Giant foxtail	7	8	7	9
Barley	2	2	0	3
Corn	0	5	4	7
Rice	0	3	5	7
Sorghum	2	3	0	3
Wheat	0	2	2	5

HERBICIDAL ACTIVITY OF COMPOUND 2(c)

	MEAN HERBICIDAL RATING			
	PRE-EMERGENT Application Rate (Kg/Ha)		POST-EMERGENT Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	9	10	10	10
Crabgrass	2	6	5	7
Cheat grass	-	-	-	-
Giant foxtail	6	8	4	9
Barley	0	3	0	2
Corn	3	4	2	9
Rice	0	4	5	7
Sorghum	0	3	2	3
Wheat	0	4	0	5

HERBICIDAL ACTIVITY OF COMPOUND 3(c)

	MEAN HERBICIDAL RATING			
	PRE-EMERGENT Application Rate (Kg/Ha)		POST-EMERGENT Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	9	10	9	10
Crabgrass	3	7	7	7
Cheat grass	2	7	3	6
Giant foxtail	5	7	7	9
Barley	0	0	0	0
Corn	5	7	7	9
Rice	5	8	7	9
Sorghum	0	0	0	0
Wheat	5	7	0	7

HERBICIDAL ACTIVITY OF COMPOUND 4(c)

	MEAN HERBICIDAL RATING			
	PRE-EMERGENT Application Rate (Kg/Ha)		POST-EMERGENT Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	0	10	9	9
Crabgrass	6	9	2	7
Cheat grass	0	4	0	3
Giant foxtail	5	9	0	9
Barley	0	0	0	0
Corn	0	0	4	7
Rice	0	0	2	8
Sorghum	0	0	0	0
Wheat	0	0	0	0

HERBICIDAL ACTIVITY OF COMPOUND 5(c)

	MEAN HERBICIDAL RATING			
	PRE-EMERGENT		POST-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	2	10	9	10
Crabgrass	0	8	2	9
Cheat grass	-	-	-	-
Giant foxtail	3	9	7	9
Barley	0	0	0	0
Corn	0	6	4	8
Rice	0	0	0	7
Sorghum	0	0	0	3
Wheat	0	2	0	4

HERBICIDAL ACTIVITY OF COMPOUND 6(c)

HERBICIDAL RATING			MEAN	
POST-EMERGENT			PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	7	10	9	10
Crabgrass	7	9	0	7
Cheat grass	0	8	2	7
Giant foxtail	5	5	5	9
Barley	0	0	0	0
Corn	0	7	3	7
Rice	0	8	5	9
Sorghum	0	0	0	0
Wheat	0	0	0	0

HERBICIDAL ACTIVITY OF COMPOUND 7(c)

HERBICIDAL RATING	POST-EMERGENT		PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
			MEAN	
Barnyard grass	0	3	9	9
Crabgrass	3	5	5	9
Cheat grass	0	3	0	0
Giant foxtail	0	2	7	9
Barley	0	3	0	2
Corn	0	5	0	9
Rice	0	0	1	8
Sorghum	0	0	2	2
Wheat	0	2	0	0

HERBICIDAL ACTIVITY OF COMPOUND 8(c)

HERBICIDAL RATING	MEAN			
	POST-EMERGENT		PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	8	9	9	10
Crabgrass	6	9	3	9
Cheat grass	0	2	0	9
Giant foxtail	5	6	8	9
Barley	0	6	5	7
Corn	0	7	3	10
Rice	0	7	8	9
Sorghum	0	2	0	0
Wheat	0	5	2	9

HERBICIDAL ACTIVITY OF COMPOUND 9(c)

MEAN HERBICIDAL RATING				
	POST-EMERGENT		PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	2	10	10	10
Crabgrass	9	10	9	10
Cheat grass	7	7	0	9
Giant foxtail	4	9	8	10
Barley	9	9	7	9
Corn	7	9	9	10
Rice	7	7	9	9
Sorghum	9	9	5	9
Wheat	6	8	6	9

HERBICIDAL ACTIVITY OF COMPOUND 10(c)

	MEAN			
HERBICIDAL RATING				
			PRE-EMERGENT	
POST-EMERGENT				
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	9	10	10	10
Crabgrass	7	10	9	10
Cheat grass	8	9	9	10
Giant foxtail	7	10	10	10
Barley	9	9	9	10
Corn	8	9	9	10
Rice	10	10	10	10
Sorghum	7	9	6	10
Wheat	8	9	9	10

HERBICIDAL ACTIVITY OF COMPOUND 11(c)

HERBICIDAL RATING	MEAN			
POST-EMERGENT			PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	3	10	10	10
Crabgrass	9	9	9	10
Cheat grass	5	8	9	9
Giant foxtail	6	9	9	9
Barley	8	10	8	10
Corn	7	9	9	10
Rice	8	10	9	9
Sorghum	8	9	7	9
Wheat	3	9	9	9

HERBICIDAL ACTIVITY OF COMPOUND 12(c)

HERBICIDAL RATING			MEAN	
POST-EMERGENT			PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	2	9	9	10
Crabgrass	2	3	9	9
Cheat grass	2	8	3	9
Giant foxtail	8	9	9	10
Barley	8	8	0	9
Corn	6	9	7	10
Rice	3	8	8	9
Sorghum	4	9	2	9
Wheat	7	8	4	9

HERBICIDAL ACTIVITY OF COMPOUND 13(c)

MEAN HERBICIDAL RATING				
	POST-EMERGENT		PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	7	10	10	10
Crabgrass	0	10	9	10
Cheat grass	3	9	3	9
Giant foxtail	7	10	9	10
Barley	6	9	6	9
Corn	8	9	10	10
Rice	5	10	9	10
Sorghum	4	9	0	9
Wheat	7	9	9	10

HERBICIDAL ACTIVITY OF COMPOUND 14(c)

MEAN HERBICIDAL RATING	POST-EMERGENT		PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	9	10	10	10
Crabgrass	10	10	9	10
Cheat grass	1	9	9	9
Giant foxtail	7	9	9	10
Barley	9	9	5	9
Corn	8	9	7	10
Rice	5	10	9	9
Sorghum	3	9	0	7
Wheat	9	9	7	9

HERBICIDAL ACTIVITY OF COMPOUND 15(c)

HERBICIDAL RATING	MEAN			
POST-EMERGENT			PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	9	10	10	10
Crabgrass	5	9	9	9
Cheat grass	5	9	9	9
Giant foxtail	8	9	9	10
Barley	9	10	5	9
Corn	8	9	8	10
Rice	9	10	9	9
Sorghum	8	9	7	9
Wheat	8	8	9	9

HERBICIDAL ACTIVITY OF COMPOUND 16(c)

MEAN HERBICIDAL RATING	POST-EMERGENT		PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	3	10	9	10
Crabgrass	8	9	9	9
Cheat grass	5	8	8	9
Giant foxtail	0	8	7	9
Barley	7	9	4	9
Corn	7	9	7	9
Rice	8	9	9	9
Sorghum	8	9	5	7
Wheat	7	9	9	9

HERBICIDAL ACTIVITY OF COMPOUND 17(c)

MEAN HERBICIDAL RATING

POST-EMERGENT			PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	7	8	9	10
Crabgrass	9	9	9	9
Cheat grass	5	8	5	9
Giant foxtail	5	9	7	9
Barley	9	9	7	9
Corn	7	9	8	10
Rice	7	9	9	9
Sorghum	8	8	8	10
Wheat	7	9	9	9

HERBICIDAL ACTIVITY OF COMPOUND 18(c)

MEAN HERBICIDAL RATING		POST-EMERGENT		PRE-EMERGENT
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	10	10	10	10
Crabgrass	6	10	9	10
Cheat grass	7	9	9	10
Giant foxtail	7	10	9	10
Barley	9	9	9	10
Corn	9	10	9	10
Rice	10	10	10	10
Sorghum	7	9	9	10
Wheat	9	10	10	10

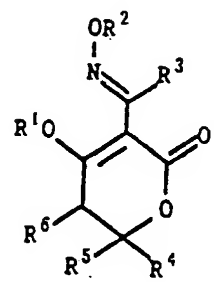
HERBICIDAL ACTIVITY OF COMPOUND 19(c)

HERBICIDAL RATING POST-EMERGENT			MEAN PRE-EMERGENT	
	Application Rate (Kg/Ha)		Application Rate (Kg/Ha)	
PLANT	0.1	0.4	0.1	0.4
Barnyard grass	6	10	10	10
Crabgrass	4	9	8	9
Cheat grass	2	9	6	9
Giant foxtail	7	9	9	10
Barley	8	9	9	10
Corn	8	9	9	10
Rice	7	10	9	10
Sorghum	4	9	5	9
Wheat	9	9	9	9

It will be clear to the reader that various modifications and variations may be made to the present invention without departing from the spirit and scope thereof.

CLAIMS

A compound of the general formula (2) or an isomeric or tautomeric form thereof:



(2)

characterised in that R^1 is selected from the group consisting of: hydrogen, alkyl; alkenyl; alkynyl; substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio, optionally substituted phenyl, optionally substituted heterocycle; optionally substituted phenyl; optionally substituted heterocycle; alkyl sulfonyl; optionally substituted benzene sulfonyl; an acyl group; and an inorganic or organic cation;

R^2 is selected from the group consisting of: alkyl; alkenyl; haloalkenyl; alkynyl; haloalkynyl; substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of halogen, alkoxy, alkylthio, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; and optionally substituted heterocycle;

R^3 is selected from the group consisting of: alkyl; fluoroalkyl; alkenyl; alkynyl; and optionally substituted phenyl;

R^4 is selected from the group consisting of: alkyl other than methyl; alkenyl; alkynyl; haloalkyl; cycloalkyl; cycloalkenyl; substituted alkyl or substituted cycloalkyl wherein the alkyl or cycloalkyl group is substituted heterocyclo; oxo; acyl; alkoxy; alkylthio; alkoxycarbonyl; (alkoxyimino)alkyl; ketal; and carboxylic acid;

R^5 is selected from the group consisting of alkyl; alkenyl; alkynyl; haloalkyl; haloalkenyl; cycloalkyl; cycloalkenyl; substituted alkyl or substituted cycloalkyl wherein the alkyl or cycloalkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio, oxo, acyl, alkoxycarbonyl, (alkoxyimino)alkyl, ketal, carboxylic acid, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; and optionally substituted heterocycle;

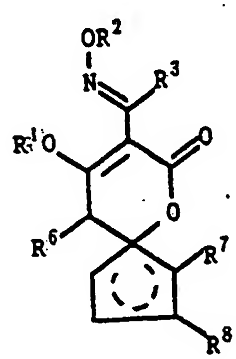
OR

R^4 and R^5 together with the carbon to which they are attached form a substituted or unsubstituted, saturated or partially saturated heterocyclic or carbocyclic ring containing 3 or more ring atom, the said ring being optionally bridged or fused; and wherein the ring substituents are selected from the

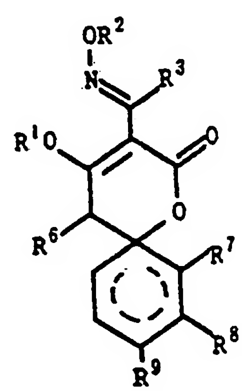
group consisting of hydrogen; alkyl; alkenyl; alkynyl; substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; optionally substituted heterocycle; oxo; acyl; alkoxy; alkylthio; alkoxycarbonyl; (alkoxyimino)alkyl; ketal; and carboxylic acid;

R^6 is selected from the group consisting of alkyl, alkoxy, alkylthio, halogen or substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio or halogen.

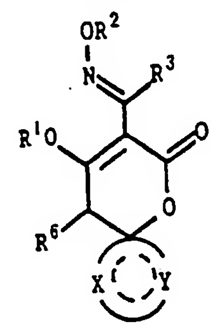
2. A compound as claimed in Claim 1, characterised in that it is a spirocyclic derivative of the general formula (3), (4) or (5)



(3)



(4)



(5)

wherein R^1, R^2 and R^3 are as specified in Claim 1;

R^7, R^8 and R^9 are selected from the group consisting of hydrogen; halo; alkyl; alkenyl; alkynyl; substituted alkyl wherein

the alkyl group is substituted with a substituent selected from the group consisting of halo, alkoxy, alkylthio, optionally substitute phenyl, and optionally substituted heterocycle; optionally substituted phenyl; optionally substituted heterocycle; oxo; acyl; alkoxy; alkylthio; alkoxycarbonyl; alkoxyimino; alkyl; ketal; and carboxylic acid.

R^5 is selected from the group consisting of alkyl, alkoxy, alkylthio, halogen or substituted alkyl wherein the alkyl group is substituted with a substituent selected from the group consisting of alkoxy, alkylthio or halogen

and wherein in the spirocyclic derivatives of formulae (3) and (4), the non-lactone ring may be saturated or partially unsaturated;

and wherein in formula (5), the polyatomic ring containing X and Y is a substituted saturated or partially saturated heterocyclic ring containing 5, 6 or 7 ring atoms, including one or more heteroatoms selected from the group consisting of oxygen, nitrogen and sulfur, and the ring is optionally substituted with a substituent selected from the group consisting of alkyl; alkenyl; oxo; acyl; alkoxy; alkylthio; ketal; alkoxycarbonyl; (alkoxyimino)alkyl; substituted alkyl wherein the alkyl group consisting of alkoxy, alkythio, optionally substituted phenyl, and optionally substituted heterocycle; optionally substituted phenyl; and optionally substituted heterocycle.

3. A compound as claimed in Claim 1 or Claim 2, characterised in that any heterocyclic ring contains more than three atoms.

4. A compound as claimed in Claim 3, characterised in that the heterocyclic ring is selected from the group consisting of thiophenyl, benzofuranyl, furanyl, morpholino, and pyridyl.

5. A compound as claimed in any one of Claims 1 to 4, characterised in that any alkyl, alkoxy, alkylthio, haloalkyl, alkyl sulphonyl or substituted alkyl groups contain from 1 to 6 carbon atoms and any alkenyl, haloalkenyl, or haloalkynyl groups containing from 2 to 6 carbon atoms.

6. A compound as claimed in any one of Claims 1 to 5, characterised in that R^1 is hydrogen or an alkali metal cation.

7. A compound as claimed in any one of Claims 1 to 6, characterised in that R^2 is alkyl, alkynyl, alkenyl or haloalkenyl.

8. A compound as claimed in Claim 7, characterised in that R^2 is ethyl, propargyl, allyl or 2- or 3-chloroallyl.

9. A compound as claimed in any one of Claims 1 to 8, characterised in that R_3 is ethyl, or n-propyl.

10. A compound as claimed in any one of Claims 1 to 9, characterised in that each of R^6, R^7, R^8, R^9 and the substituents of the polyatomic chain XY in formula (5) is individually hydrogen or methyl.

11. A compound as claimed in any one of Claims 1 to 9, characterised in that R^6 is methyl or ethyl.

12. A compound as claimed in Claim 1, selected from the group consisting of:

8-[1-ethoxyimino)butyl]-9-hydroxy-10-methyl-6-oxaspiro-[4.5]dec-8-en-7-one;

8-[1-((2-chloro-2-propenyl)oxyimino)butyl]-9-hydroxy-10-methyl-6-oxaspiro[4.5]dec-8-en-7-one;

8-[1-(ethoxyimino)butyl]-10-ethyl-9-hydroxy-6-oxaspiro[4.5]dec-8-en-7-one;

8-[1-((2-chloro-2-propenyl)oxyimino)butyl]-10-ethyl-9-hydroxy-3-methyl-6-oxaspiro[4.5]dec-8-en-7-one;

3-[1-((2-chloro-2-propenyl)oxyimino)butyl]-4-hydroxy-5-methyl-1-oxaspiro[5.5]undec-3-en-2-one;

3-[-1((3-chloro-2-propenyl)oxyimino)butyl]-4-hydroxy-5-methyl-1-oxaspiro[5.5]undec-3-en-2-one;

3-[1-(ethoxyimino)butyl]-5-ethyl-4-hydroxy-9-methyl-1-oxaspiro[5.5]undec-3-en-2-one;

3-[1-((2-propenyl)oxyimino)butyl]-5-ethyl-4-hydroxy-9-methyl-1-oxaspiro[5.5]undec-3-en-2-one;

8[-(ethoxyimino)butyl]-9-hydroxy-10-methyl-6-oxa-2-thiaspiro[4.5]dec-8-en-7-one;

8[1-((2-propenyl)oxyimino)butyl]-9-hydroxy-10-methyl-6-oxa-2-thiaspiro[4.5]dec-8-en-7-one;

8[1-((2-chloro-2-propenyl)oxyimino)butyl]-9-hydroxy-10-methyl-6-oxa-2-thiaspiro[4.5]dec-8-en-7-one;

9-[1-(ethoxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-2-thiaspiro[5.5]undec-8-en-7-one;

9-[1-((2-chloro-2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-2-thiaspiro[5.5]undec-8-en-7-one;

9-[1-((3-chloro-2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-2-thiaspiro[5.5]undec-8-en-7-one;

9-[1-(ethoxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one;

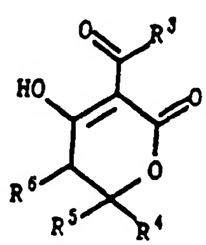
9-[1-((3-chloro-2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one;

9-[1-((2-chloro-2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one;

9-[1-((2-propenyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one; and

9-[1-((2-propynyl)oxyimino)butyl]-10-hydroxy-11-methyl-7-oxa-3-thiaspiro[5.5]undec-8-en-7-one.

13. A method for preparing a compound of formula (2) as stated and defined in Claim 1, characterised in that a hydroxypyranone of the formula (8)



(8)

is reacted with an alkoxyamine of the formula R^2ONH_2 to give a compound of formula (2) wherein R^1 is hydrogen and R^3, R^4, R^5 and R^6

are as defined in Claim 1 and, when required, the hydroxyl group (R^1O-) is converted into the desired ester or salt (wherein R^1 is other than hydrogen).

14. A method for preparing a compound of formula (8) as stated and defined in Claim 13, characterised in that an acetoacetate of the formula $R^6CH_2COCH_2CO_2R$ wherein R^6 is as defined in Claim 1 and R is an esterifying group is converted into the dianion $[R^6C^{\ominus}HCOC^{\ominus}HCO_2R]$ by reaction with (a) sodium hydride then (b) n-butyllithium; the dianion is reacted with a ketone of the formula R^4COR^5, wherein R^4 and R^5 are as defined in Claim 1, the resulting product is hydrolysed and cyclized to give a hydroxypyranone which is esterified with an acyl halide and the product rearranged in the presence of 4-dimethylaminopyridine to give a compound of formula (8).

15. A plant growth inhibiting, plant damaging, or plant killing composition comprising a compound of formula (2), as defined in any one of Claims 1 to 12, and an inert carrier therefor.

16. A herbicidal composition comprising a mixture of at least one herbicidal compound of formula (2) as defined in any one of Claims 1 to 12, with at least one other herbicide.

17. A method for regulating the growth of a plant which process comprises applying to the plant, to the seed of the plant,

or to the growth medium of the plant, an effective amount of a compound of formula (2), as defined in any one of Claims 1 to 12.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/AU 89/00191

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] C07D 309/32, 495/10, A01N 43/16, 43/18

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC	C07D 309/32, 495/10

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8

AU: IPC as above, AUSTRALIAN CLASSIFICATION 09.171

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category*	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
A	AU,B,27196/84 (560716) (ICI AUSTRALIA LIMITED) 22 November 1984 (22.11.84)	1-13, 15-17
A	AU,A,77583/87 (DUNLENA PTY LIMITED) 11 February 1988 (11.02.88)	1-13, 15-17
A	Chemical Abstracts, Volume 86, no. 11 issued 1977 (Columbus, Ohio, USA) Sawaki, M et al "Herbicidal 3-(N-alkoxyacylimidayl) -4-acyloxy-5, 6-dihydro-sH-pyranones". See page 595, column 1, abstract no. 72439y, Japan Kokai 76 63, 175 pat. applicat. 74/135,159.	1-13, 15-17

* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11 July 1989(11.07.89)	27 July 1989
International Searching Authority	Signature of Authorized Officer
Australian Patent Office	CA BRICK

Form PCT/ISA/210 (second sheet) (January 1985)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. [] OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE 1

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [] Claim numbers ...., because they relate to subject matter not required to be searched by this Authority, namely:

2. [] Claim numbers ...., because they relate to parts of the international application that do comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [] Claim numbers ...., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4 (a):

VI. [X] OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING 2

This International Searching Authority found multiple inventions in this international application as follows:

Invention 1: Claims 1-13, 15-17. Claims directed to compounds, methods of preparation, compositions and uses of compounds of formula 2.

Invention 2: Claim 14. Claim directed to preparation of compound of formula 8.

1. [] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. [] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. [X] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
1-13, 15-17
4. [] As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

[] The additional search fees were accompanied by applicant's protest.

[] No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 89/00191

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
AU 77583/87	EP 275287	WO 8800945	ZA 8705591
AU 27196/84	GB 2140803		

END OF ANNEX